Project Planning & Control

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Lecture – 21

Lesson - 03

Two- Span Bridge: Activity Identification and Duration Estimation (Contd.,)

In this session, what we are going to do is discuss a small case study which is the Two Span Bridge problem. What we want to do is to be able to apply some of the theory we have learnt and see, what it results in especially with respect to obviously, network planning.

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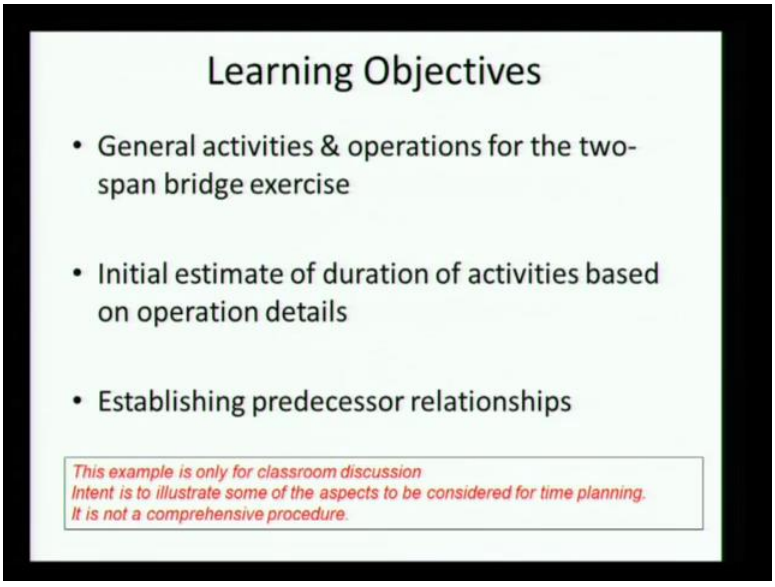

I want to be able to kind of a explain, how estimation of duration is done for these activities using the bridge as an example, we will also establish predecessor relationship and basically, we will really get into the details of the two span bridge problem. Now, like you can see the bottom of this slide, we will get into a lot of practical details, but this is only indicator, this is only for class room discussion and this is by no means is a comprehensive procedure for bridge scheduling. There is a lot more detail one has to get into.

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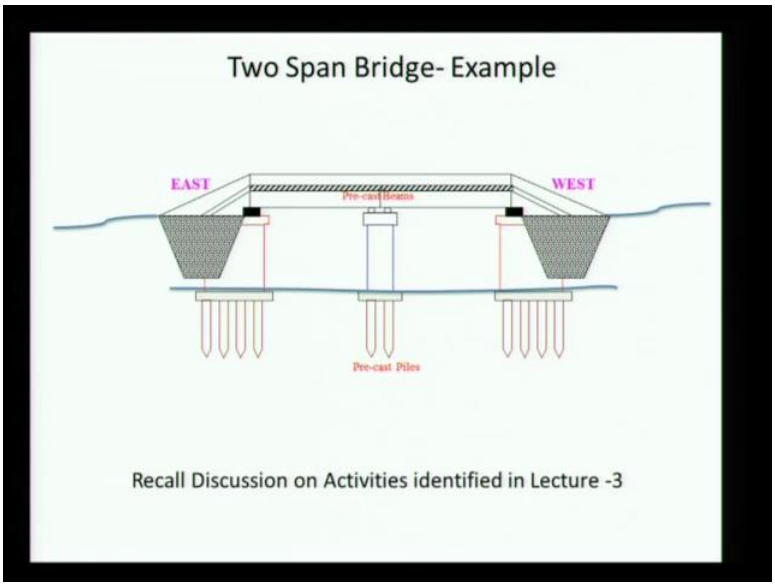

Now, you recall this, so this was something we had discussed in lecture 3 about the various elements of the bridge and we had used it to identify activities.

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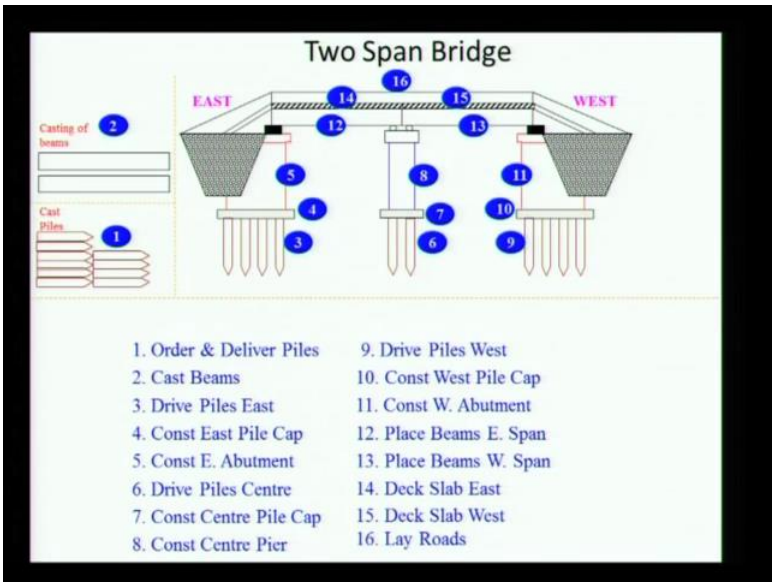

So, let us actually look at this once more, so that you familiarize yourself with the activity. These are the activities we had identified. We had said there is activity 1. So, when we look at the bridge it is a two span bridge, so there is span 1, span 2. You have two abutments, a centre pier, you have piles, so these are indication of piles, we have a pile cap, each of the pile groups have a pile cap. And then, you have the girders across, you have a slab deck, the road over it, the abutment has earth work here and then, the road leading up to the decks and leading away up to the decks on the east and the west

side.

So, these were the components of the bridge and then, we decided that we would break it down into the following activities. So, we will get into a little, we will this is what we will get into details of today. One is, I would to the best of what we can do in the class room show you, what these activities look like and the real objective is to estimate the duration of the activities and towards the end of the lecture we will see, what is the sequence in which these activities can be done for the bridge should be constructed.

So, that will give us enough information to do network analysis. So, you can see the first activity we are saying here is order and deliver piles, then we are talking about casting the beams, driving the piles in the east, they constructing the pile cap, constructing the abutment here, driving the piles in the center, constructing the center pile cap, constructing the center pier, driving the piles on the west, again the pile cap, the abutment, then placing these beams here, placing the second set of beams and then, the deck slab is over the beams and then finally, laying the road over this.

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So, let us get into, so again just I am repeating; our objective is to understand what makes up these activities; that is, one and number 2 is to be able to see, how would we estimate duration of these activities. So, let us get into the first activity order and deliver piles. So, what we have assumed or when we say order and deliver piles that is a precast piles is available for you from a kind of a fabrication factory to be able to order and deliver piles.

So, you can see here, if you have not visited a precast yard, it is something which you should do in as a part of an industrial visit. So, you will have molds like this into which concrete are poured , concrete is poured ((Refer Time: 04:13)) and then, it is striped, cured and you will have piles ready for delivery in this form. And if you place orders, these are standard length standard dimension and I can base the number of my foundation design based on the piles and number of piles.

So, if you cannot order piles, you know in your area you might have to set up a precast yard in your site, which does something like this and these piles are then driven into the ground. Now, other than this precast pile, what are the other kinds of piles.

Student: Cast insitu

Cast insitu, where you actually pour and then, you cast this pile cap. Here the advantage here is they come precast, so you can start the way of your operation right away and this case we have chosen to do precast.

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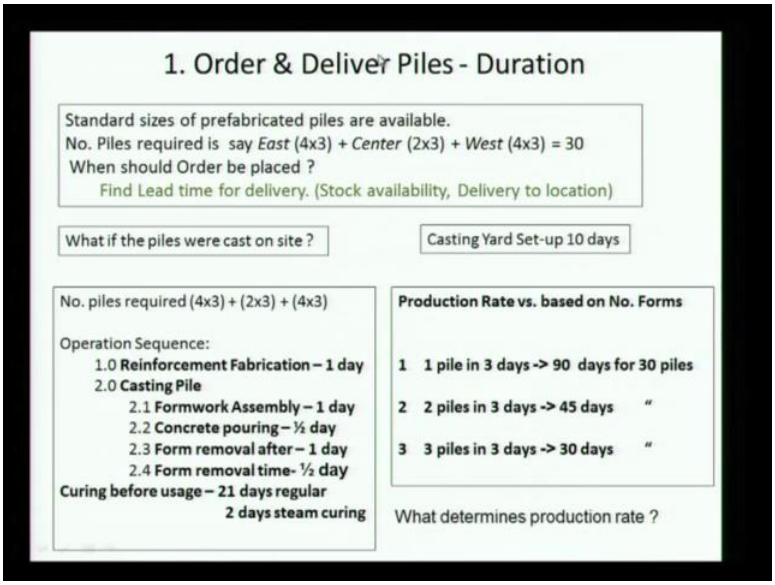

Now, how do I estimate duration? So, this is a, this slide is a bit busy, but let us see what we can make out as to coming out to estimating durations for precast pile. The simplest one is let us say if I have to order the piles, what I have to decide is, what is the lead time for delivery. If I am going to place an order on a certain item I have to know I cant go to the precast order and say I want 20 piles and he will deliver it to be by evening, it is very unlikely, he will need a certain amount of time, because he will have back log of orders and things, I will have to find the lead time and then, place my order based on the lead

time.

What else does time of delivery depend. If I was going to precasting kind of a factory, what else will it depend. Transportation, location where it is, transportation time, is it interstate, if it interstate there will be a lot of other things to take care of. So, lot of these decide whether you are going to do it on site or off site, also a number of piles. If I have a very large order, it is not single delivery it is going to take time for them to pre fabricate, ship it, you know there will be many cycles of it.

So, here we are saying there are 30 piles, because they are relatively small bridge and we are saying the pile group here. So, you can see a 4 / 3, a 2/3 and a 4/3. So, that is the number, so if I, if you want to interpret what this 4 /3 and 2/ 3 is, we are assuming that the piles are in the form of a group.

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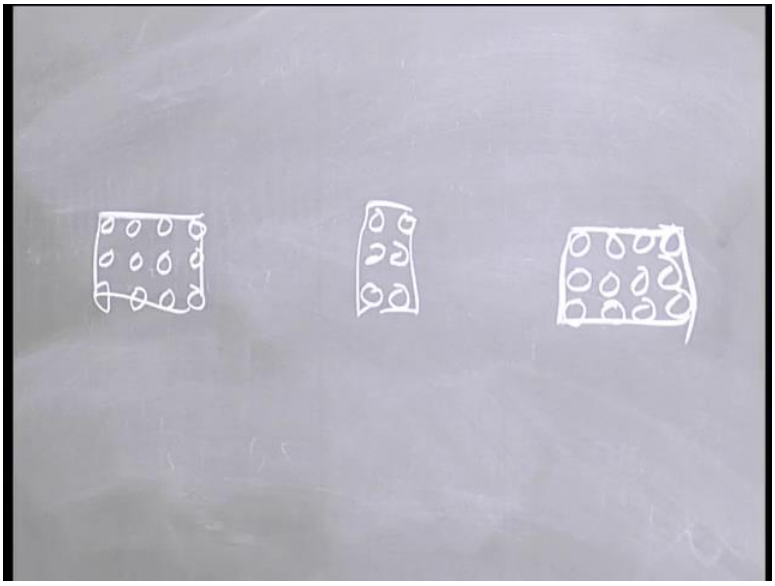

So, you have 1, 2, 3, 4, so this is for one of the abutments for the… So, for the pier is this way and for the other abutment that is similar to this. So, ……<7.21 seconds> this is the how we get the numbers, now I have not decided or given you information on depth of the pile or the dimension of the pile, because you are assuming all that is fairly standard. We should be getting into that detail if you are doing a real planning, but right now we are just making an assumption and going for the class room for this.

So, if I were to do a delivery I just find it is going to take me one month to from when I place the order to get the piles, then I have to place the order one month ahead of when I want the piles. Now, the other alternative is which I have shown here is that I do not

want lets say I decide to cast the piles on site. What is the operations required? So, you can see from the earlier things , see it will have certainly reinforcement cage, it has form work.

So, this is the typical sequence of operation, I have to do, I have to fabricate the reinforcement cage, I have to cast the pile, I have to assemble the form work, pour the concrete, remove the forms after one day, I cannot remove the forms immediately. So, which has set there and I am allowing one day for the concrete to set, I am probably be needing less time, but I am allowing one day and then, actual time for removing the form.

And then, I might decide I want to use it, cure it for 21 day before I actually use it. I have to allow the concrete to gain strength. Now, if I wanted it to gain strength rapidly, I could use stream cure, so it depends. So, you can imagine now from when my first pile goes in to the casting I will be able to use it only after, how many days? let us say I start casting and I am assume that reinforcement fabrication, I will assume that it is all sequential.

Student: 25 days

Above 25 days and how to which, 21 is just going for?**Student:** Curing.

Curing, there is no activity happening, it just curing. So, lot of time peoples say look at I do not wait for the 21 days, I am going to steam curing it and start using this value. so here you can see multiple fabrication beds, if I had only one mold it will take more time. So, how many molds? So, I need 30 piles. How many mold should I invest in? Is there another critical, you know driver of my rate of production of piles.

So, here you can see you know if I have, here if you just take a look here, I have one day for reinforcement fabrication, form work assembly, concrete pouring. It is, so here you have two and half days, I remove the form after one day. So, here 1 2 3 4 days, after four days I can reuse the form work, after four days I can reuse the form work so you have to make a calculation in that form and say that, so in my next pile I would put it back on the fourth day and then restart.

So, if I have multiple such a forms what will be the way I go, ((Refer Time: 10:51)) we are leaving the actual what do you call. So, you can see the duration here can be determined based on the rate at which my bridge needs piles, I could just have one form and go with it, but is that likely to be good; no, because piling is the first activity. So, if I want to start my piling work I better have many piles there and so that was one reason

why just ordering and delivering might be an easier approach so long as my lead time is there.

If something like this, I have to do a casting yard set up and there is many things to do, before we get up. So, Ive just given you an alternative that we can actually as an exercise later come back and determine the number of form sets I need to ensure that my project has minimum delay. Any questions on this? We go to the next activity which is casting the beams.

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It is similar, so here you can see a casting bead; again you have reinforcement; you are going to actually pour concrete, wait for it to set, remove the form work and land up with the beam and the I girder something like this. Then, I girder get is then transported to the place and lifted in place in to the over the as the part of the bridge structure. Now, we come to the same question here in this case we are saying that beam casting is part of the project and we are assuming that there is a total of 6 beam required 3 + 3, 3 on the one span 3 on the other and the sequence of beam fabrication is a like this.

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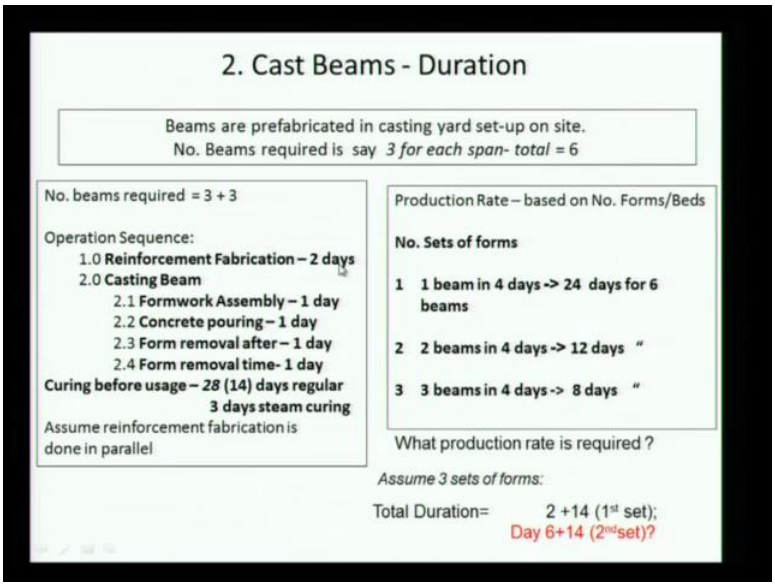

So, you have two days for the reinforcement and when you casting the beam assembly is one day the concrete poring is one day form removal after one day the time for a moving the form is one day. Now, curing before usage, now beam is going to be flexural ((Refer Time: 12:58)) it is you know you are going to take it is going to be challenge by whatever loads are coming on it, but typically by the time we left in place on 14 days it will obtain a full strength and you know soon enough before this service load comes on it.

So, general leave 14 days is enough in again if you really want to take it earlier we have to use stream curing. Now, so if we take this beam duration for casting beams, let us get in to little bit of detail and see if if these number here are can we come up with the different numbers. First of all when we take casting a beam we are taking we need 6 beams cast and how many days does it take the cast a beam.

So, we can assume now if I am going to do, so can reinforcement fabrication be done in parallel ? yes, which means what you I do? what is the sequence?. So, you will find the this reinforcement can be tied somewhere else placed here and then, the form work can be build around it . So, I do not need two days this in sequence to the casting part of it. So, basically if we get in to detail. So, assume that reinforcement fabrication is available that takes the 1 2 3 4 days before a form is ready again.

So, basically assume that you know the reinforcement yard is producing reinforcement and it is available very rapidly I just need to take it or you know as it is I need to take it

put it in to the form assemble the form pore the concrete wait for one day remove it and then, the form is the ready again. So, in one day I can produce in 4 days I can produce one beam. So, if I go with you know 3 forms in 4 days I can produce 3 beams.

Now, again we can ask what is the production do it required if I have to get 4 sets, then means I have 3 sets I have to then invest more have more space all of that is required does it benefit me it one of the questions we going to discuss will this by going in with three will it be beneficial towards the, now when does not beam get erected. It is quite late in the project, you know can I just do it in one set of forms or do I need multiple?, what is the disadvantage of one set of forms was multiple will discuss all of these in a later change I thing all of you realize that this is an issue.

So, here we go will a assume a three such a form and then, can you convince yourself can you tell me this is ok ? or what have we done what is what is shown below what is a duration how do I calculate the duration, what is it, what is 2 + 14.

Student: 14 days.

For curing yeah, what is two.

Student: Formwork assemblyWhy I am not taking 4 days+ 14

Student: Because formwork removal and all is later, even though when we remove formwork the concrete is curing ((Refer Time: 16:31)).

Exact, so I have done my form work assembly Ive poured my concrete, concrete has started curing started gaining strength from that day. So, it is to these two days and then it is I am allowing it cure for 14 days. So, and on this basically 16th day from the start that beams that set of beam ready what about the second set of beams these once you the formwork is free …..I have gone in. So, just that make set of beam the ready four days late on also cure for yeah 14 day.

So, it goes to twenty days now if you recall when we going, so here I have actually split this in to two I have if I am taking duration I have a duration of 16 days for first set of beams what is the duration of second set of beams ((Refer Time: 17:34)) 20 digit complete by 20 days yes, so from when I start 20 days. So, both set of beams will be available in 20 days the …we will come, so here I am showing it as tw0 I have not shown it is to am showing two components to the time. we can decide whether this kind of breaking it will be useful at a later stage or not any questions ? sir the reinforcement

fabrication?.

So reinforcement fabrication, so you are fabricating all the reinforcement is it ? what reinforcement fabrication requires is it typically we run a reinforcement yard yeah I need crew for it. So, so all we are saying here is that it takes two days of fabrication reinforcement, y I am not doing it in sequence I am doing it in parallel the reinforcement cage is brought to the to the bed and then this is placed in before the forms.

So, I do not need to wait I mean if I have enough crew I can fabricate reinforcement for all 6 at this same time and then, place it in where we are going to pour the concrete that is exactly what it means it means that this reinforcement is not I am not fabricating the reinforcement on the bed and the fabricating the out. So, the bed is free and then bringing it and the placing it on the bed doing whatever tying is required and then, doing the form work around how would it change if I am fabricating the reinforcement on the bed it will add two days it will constraint that resource of the bed till that in reinforcement fabrication is also complete. In piling did we assume that we will have to go back you can you can go back in see in piling it in assumed.

So, we are going to have assume that it was fabricated on the bed it varies, it depends you known if you if you take reinforcement it depends on you know what kind of lifting you can do how far you have to move it depends on various issues.

Student: ((Refer Time: 19:49)) Even of the first set is not free you need 4 sets to fabricate the reinforcement

You need the days to fabricate the reinforcement, you are right absolutely right. But in the second day You do not need it, yeah you are totally right on that I didn’t put it because if you had a series of what you do then it becomes the continuous process and not the initial, in the initial part you really need